Case Study: Vibration-Powered Engine Monitoring

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The health of machinery, such as motors and engines, is commonly monitored by measuring their vibration characteristics. Often, this is carried out manually, with a piece of portable equipment being used periodically to measure the vibration characteristics at a number of locations. Changes in the vibration signature can give early indication of problems developing (e.g. bearing failure). This means that faults can be resolved before they cause a breakdown, reducing maintenance costs and improving the reliability and up-time of machinery. For critical assets, such condition monitoring equipment can be permanently installed and carry out measurements continuously. For this to happen, the equipment is normally hard-wired; alternatively, it may operate wirelessly, but this means it needs to be battery-powered. However, batteries need periodic replacement, which increases the maintenance commitment.

Fig. 1: Application: monitoring ferry engines

Fig. 2: Eight-cylinder diesel main engine on ferry

We have worked with Red Funnel, which operates ferries between Southampton and the Isle of Wight (Fig. 1), to develop a self-powered condition monitoring system for their engines (Fig. 2). Unlike conventional vibration energy harvesters, which are narrow-band and only suitable for deployment on electrical machinery powered from the grid, our system is based on a tunable vibration energy harvester (Fig. 3). Tunable harvesters had, until now, only been demonstrated in the lab and had not matched the vibration characteristics found on real machines. We have deployed a tunable vibration energy harvesting system in this real application (Fig. 4), which powers a wireless condition monitoring sensor system. It both monitors, and is powered by, the vibration of the main engine!

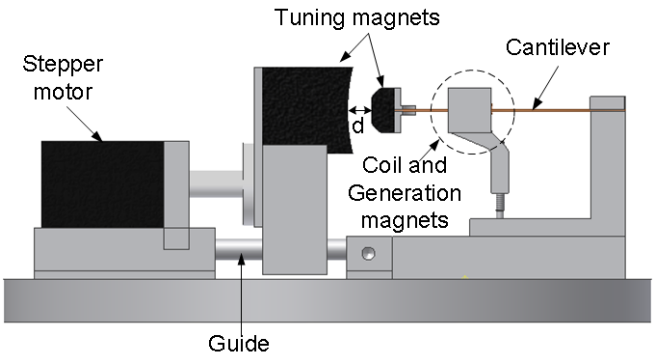

Fig. 3: Elevation view of tunable harvester

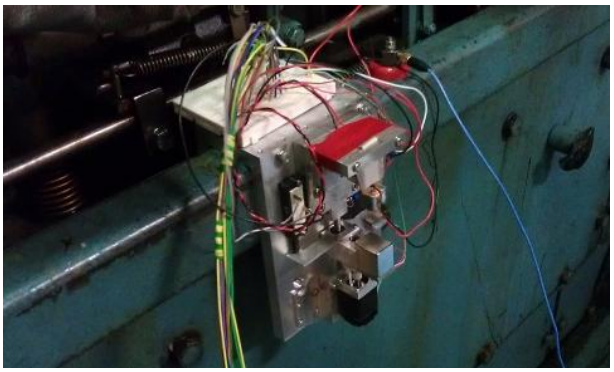

Fig. 4: System under test on engine

Publications

see http://www.holistic.ecs.soton.ac.uk/publications.php

A. S. Weddell, D. Zhu, G. V. Merrett, S. P. Beeby, B. M. Al-Hashimi, "A practical self-powered sensor system with a tunable vibration energy harvester". In PowerMEMS 2012, Atlanta, US, 2-5 Dec 2012.

A. S. Weddell, G. V. Merrett, S. Barrow, B. M. Al-Hashimi, "Vibration-powered sensing system for engine condition monitoring", IET WSS 2012, London, June 2012.

Other Resources, News and Events

see www.holistic.ecs.soton.ac.uk/resources.php

Video: Demonstrator System being Deployed on Ferry Engine

An overview of our demonstrator deployment, including a video from Dr Alex Weddell, University of Southampton. See inside the engine room on the Red Funnel ferry, and the energy harvester in action.

Video: Vibration-Powered Sensing System for Engine Condition Monitoring

A presentation at the recent IET Wireless Sensor Systems 2012 conference by Dr Geoff Merrett, University of Southampton.

Real Vibration Data Available for Free Download

Vibration energy harvesters behave very differently in real environments than when they are exposed to synthetic vibration conditions in the lab. To address this problem, we have collected long-term vibration data from a range of applications (including vehicles, machinery, and humans), some of which are shown below. These data sets are now available for free download from the Energy Harvesting Open Access Data Repository (www.eh-network.org/data), which is managed by the Energy Harvesting Network.